AMENDMENTS TO THE CLAIMS

A detailed listing of all claims that are, or were, in the present application, irrespective of whether the claim(s) remains under examination in the application are presented below. The claims are presented in ascending order and each includes one status identifier. Those claims not cancelled or withdrawn but amended by the current amendment utilize the following notations for amendment: 1. deleted matter is shown by strikethrough for six or more characters and double brackets for five or less characters; and 2. added matter is shown by underlining.

1. (Currently amended) A unit fuel injector, the injector internally preparing fuel during an injection event at a pressure sufficient for injection into an internal combustion engine by means of an intensifier piston, comprising:

a single needle valve for injecting a single fuel into the internal combustion engine; and

a selectively actuatable controller being in fluid communication with a source of pressurized actuating fluid and being in fluid communication with a substantially ambient actuating fluid reservoir, the controller having a first valve responsive to a first electric actuator for selectively independently porting actuating fluid to and venting actuating fluid from the intensifier piston and a second valve responsive to a second electric actuator for selectively independently porting actuating fluid to and venting actuating fluid from [[a]] the needle valve during the injection event for controlling opening and closing of the needle valve.

2. (Original) The unit fuel injector of claim 1 wherein the two valves are disposed in a coaxial arrangement.

3. (Original) The unit fuel injector of claim 2 wherein the two valves are independently electrically actuated.

4. (Original) The unit fuel injector of claim 3 wherein each of the two valves are independently solenoid operated in a first direction and spring operated in an opposed second direction.

5. (Original) The unit fuel injector of claim 1 wherein the second valve is operably fluidly coupled to a needle valve first closing surface.

6. (Original) The unit fuel injector of claim 5 wherein actuating fluid ported by the second valve to the needle valve first closing surface generates a force acting to close the needle valve.

7. (Original) The unit fuel injector of claim 6 wherein the actuating fluid ported by the second valve to the needle valve first closing surface generates a force that is greater than an opposing force acting on a needle valve opening surface, the opposing force being generated by pressurized fuel.

8. (Original) The unit fuel injector of claim 5 wherein actuating fluid is being ported by the first valve to the intensifier piston, the actuating fluid ported by the second valve to the needle valve first closing surface acting to put the intensifier piston into a state of hydraulic lock.

9. (Original) The unit fuel injector of claim 8 wherein the second valve venting the actuating fluid ported to the needle valve first closing surface acts to free the intensifier piston from the state of hydraulic lock, the needle valve then being openable by the action of fuel pressurized by the intensifier piston acting on a needle valve opening surface.

10. (Original) The unit fuel injector of claim 5 wherein the second valve is cyclable between an open and a closed disposition a plurality of times during a single cycle of the first valve to effect a plurality of fuel injections and dwell periods during a single injection event.

11. (Original) The unit fuel injector of claim 5 wherein the second valve is shiftable to port actuating fluid to the needle valve first closing surface prior to shifting of the first valve to port actuating fluid to the intensifier piston, subsequent porting of the actuating fluid by the first valve to the intensifier piston acting to effect prebuilding fuel pressure.

12. (Original) The unit fuel injector of claim 1 further including a needle back piston being operably coupled to the needle valve.

13. (Original) The unit fuel injector of claim 12 wherein the needle back piston is in fluid communication with the second valve.

14. (Original) The unit fuel injector of claim 13 wherein the needle back piston is translatably disposed in a bore, the bore defining a portion of a variable displacement chamber, a needle valve first closing surface of the needle back piston defining in part the variable displacement chamber.

15. (Original) The unit fuel injector of claim 14 wherein a return spring is disposed in the variable displacement chamber, the return spring exerting a bias on the needle valve first closing surface.

16. (Original) The unit fuel injector of claim 15 wherein the return spring bias on the needle valve first closing surface acts in cooperation with a fluid pressure on the needle valve first closing surface to generate a closing force on the needle valve.

17. (Original) The unit fuel injector of claim 16 wherein the needle valve first closing surface has an area exposable to actuating fluid that is sufficient for the generation of a closing force on the needle valve, the closing force exceeding an opposing needle valve opening force generated by high pressure fuel acting on the needle valve for a certain range of pressures of the actuating fluid.

18. (Original) The unit fuel injector of claim 12 wherein the needle back piston includes a shank, the shank bearing on a top margin of the needle valve.

19. (Original) The unit fuel injector of claim 18 wherein the top margin of the needle valve defines in part a chamber, the chamber being vented to a substantially ambient fuel return.

20. (Original) The unit fuel injector of claim 14 wherein the bore defines a portion of a second variable displacement chamber in cooperation with the needle back piston, the second

variable displacement chamber being vented to the substantially ambient actuating fluid reservoir.

21. (Currently amended) A method of injection control for a fuel injector having only one needle valve for injecting fuel, comprising;

fluidly coupling a selectively actuatable controller with a source of pressurized actuating fluid and with a substantially ambient actuating fluid reservoir; and

controlling opening and closing of the one needle valve by;

a. selectively independently porting actuating fluid to and venting actuating fluid from an intensifier piston by means of a first valve by means of a first electric actuator; and

b. selectively independently porting actuating fluid to and venting actuating fluid from a needle valve during an injection event by means of a second valve by means of a second electric actuator.

22. (Original) The method of claim 21 including disposing the two valves in a coaxial arrangement.

23. (Original) The method of claim 22 including independently electrically actuating the two valves.

24. (Original) The method of claim 22 including independently solenoid operating each of the two valves in a respective first direction and spring operating the two valves in a respective opposed second direction.

25. (Original) The method of claim 21 including operably fluidly coupling the second valve to a needle valve first closing surface.

26. (Original) The method of claim 25 including generating a force acting to close the needle valve by porting actuating fluid by the second valve to the needle valve first closing surface.

27. (Original) The method of claim 26 generating a force by the second valve porting actuating fluid to the needle valve first closing surface, the force being greater than an opposing force acting on a needle valve opening surface by pressurized fuel.

28. (Original) The method of claim 27 including hydraulically locking the intensifier piston by the second valve porting actuating fluid to the needle valve first closing surface.

29. (Original) The method of claim 28 including unlocking the intensifier piston by the second valve venting the actuating fluid ported to the needle valve first closing surface and subsequently opening the needle valve by action of fuel pressurized by the intensifier piston acting on a needle valve opening surface.

30. (Original) The method of claim 25 including effecting a plurality of fuel injections and dwell periods during a single injection event by cycling the second valve between an open and a closed disposition a plurality of times during a single cycle of the first valve.

31. (Original) The method of claim 25 including prebuilding fuel pressure by:

shifting the second valve to port actuating fluid to the needle valve first closing surface;

subsequently shifting the first valve to port actuating fluid to the intensifier piston; and

subsequently venting the actuating fluid by the second valve.

32. (Original) The method of claim 25 including:

continually exposing a second needle valve closing surface to actuating fluid; and

generating a force on the second needle valve closing surface by pressurized actuating fluid effecting a needle valve valve opening pressure, the valve opening pressure being overcomable by a force of pressurized fuel acting on a needle valve opening surface.

33. (Original) The method of claim 32 including:

varying the needle valve valve opening pressure as a function of the pressure of the actuating fluid; and

varying the actuating fluid pressure at least as a function of an engine operating speed.

34. (Original) The method of claim 21 including the first valve porting actuating fluid to the intensifier piston a single time during an injection event.

35. (Original) The method of claim 34 including the second valve porting actuating fluid to the needle valve to end injection prior to cessation of the first valve porting actuating fluid to the intensifier piston the single time during an injection event.

36. (Original) The method of claim 21 including effecting an injection control strategy during an injection event by selective porting of actuating by the second valve to the needle valve.

37. (Original) The method of claim 36 including slowly ramping up the rate of injection by the second valve venting the needle valve prior to the first valve porting actuating fluid to the intensifier piston.

38. (Original) The method of claim 36 including effecting a dwell in the rate of injection by the second valve porting actuating fluid to the needle valve and subsequently venting the needle valve while the first valve is porting actuating fluid to the intensifier piston.

39. (Original) The method of claim 36 including terminating injection by the second valve porting actuating fluid to the needle valve while the first valve is porting actuating fluid to the intensifier piston, the first valve subsequently venting the intensifier piston.

40. (Original) The method of claim 36 including varying a valve opening pressure of the needle valve by varying the pressure of the actuating fluid ported by the first valve to the needle valve.

41. (Currently amended) A hydraulically actuated, intensified fuel injector having only one needle valve for injecting fuel, comprising:

a controller achieving a desired injection control strategy by selectively independently porting actuating fluid to and venting actuating fluid from an intensifier piston to control the compressive stroke of the intensifier piston and selectively independently porting actuating fluid to and venting actuating fluid from [[a]]the one needle valve to control the opening and closing of the one needle valve during the injection event.

42. (Original) The unit fuel injector of claim 41 wherein the controller includes a first and a second valve, the two valves being disposed in a coaxial arrangement.

43. (Original) The unit fuel injector of claim 42 wherein the two valves are independently electrically actuated.

44. (Original) The unit fuel injector of claim 43 wherein each of the two valves are independently solenoid operated in a first direction and spring operated in an opposed second direction.

45. (Original) The unit fuel injector of claim 42 wherein the second valve is operably fluidly coupled to a needle valve first closing surface.

46. (Original) The unit fuel injector of claim 45 wherein actuating fluid ported by the second valve to the needle valve first closing surface generates a force acting to close the needle valve.

47. (Original) The unit fuel injector of claim 46 wherein the actuating fluid ported by the second valve to the needle valve first closing surface generates a force that is greater than an opposing force acting on a needle valve opening surface, the opposing force being generated by pressurized fuel.

48. (Original) The unit fuel injector of claim 45 wherein actuating fluid is being ported by the first valve to the intensifier piston, the actuating fluid ported by the second valve to the needle valve first closing surface acting to put the intensifier piston into a state of hydraulic lock.

49. (Original) The unit fuel injector of claim 48 wherein the second valve venting the actuating fluid ported to the needle valve first closing surface acts to free the intensifier piston from the state of hydraulic lock, the needle valve then being openable by the action of fuel pressurized by the intensifier piston acting on a needle valve opening surface.

50. (Original) The unit fuel injector of claim 45 wherein the second valve is cyclable between an open and a closed disposition a plurality of times during a single cycle of the first valve to effect a plurality of fuel injections and dwell periods during a single injection event.

51. (Original) The unit fuel injector of claim 45 wherein the second valve is shiftable to port actuating fluid to the needle valve first closing surface prior to shifting of the first valve to port actuating fluid to the intensifier piston, subsequent porting of the actuating fluid by the first valve to the intensifier piston acting to effect prebuilding fuel pressure.

52. (Original) The unit fuel injector of claim 42 further including a needle back piston being operably coupled to the needle valve.

53. (Original) The unit fuel injector of claim 52 wherein the needle back piston is in fluid communication with the second valve.

54. (Original) The unit fuel injector of claim 53 wherein the needle back piston is translatably disposed in a bore, the bore defining a portion of a variable displacement chamber, a needle valve first closing surface of the needle back piston defining in part the variable displacement chamber.

55. (Original) The unit fuel injector of claim 54 wherein a return spring is disposed in the variable displacement chamber, the return spring exerting a bias on the needle valve first closing surface.

56. (Original) The unit fuel injector of claim 55 wherein the return spring bias on the needle valve first closing surface acts in cooperation with a fluid pressure on the needle valve first closing surface to generate a closing force on the needle valve.

57. (Original) The unit fuel injector of claim 56 wherein the needle valve first closing surface has an area exposable to actuating fluid that is sufficient for the generation of a closing force on the needle valve, the closing force exceeding an opposing needle valve opening force generated by high pressure fuel acting on the needle valve for a certain range of pressures of the actuating fluid.

58. (Original) The unit fuel injector of claim 52 wherein the needle back piston includes a shank, the shank bearing on a top margin of the needle valve.

59. (Original) The unit fuel injector of claim 58 wherein the top margin of the needle valve defines in part a chamber, the chamber being vented to a substantially ambient fuel return..

60. (Original) The unit fuel injector of claim 54 wherein the bore defines a portion of a second variable displacement chamber in cooperation with the needle back piston, the second variable displacement chamber being vented to the substantially ambient actuating fluid reservoir.

Claim Rejecti n under 35 USC 102

Claims 1, 5-8, 10, 11-19, 41-47, 50, 52. 53, 58 and 59 were rejected under 35 U.S.C. § 102(b) as being anticipated by Touchette et al. (U.S. Pat. No. 6,073,862). Touchette discloses an injector that utilizes a first needle valve (valve 16) to inject a first fuel as a pilot injection and a second needle valve (valve 17) to inject a second fuel as the main injection.. Touchette needs the two different needle valves since it is designed to inject both a liquid fuel (pilot injection) and gaseous fuel (main injection). The design of the present invention is much simpler, being confined to a single fuel. The present invention effects pilot and main injection with a single needle valve. There is no structure, teaching or suggestion in Touchette for use of a single needle valve. The independent claims of the present application have been amended to reflect this limitation. It is believed that the claims of the present application are not now anticipated by the Touchette reference and it is requested that the rejection be withdrawn.

Claim Rejection under 35 USC § 103

Claims 2-4 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Touchette et al. in view of Chen et al. Claims 21-28, 30-34, 36 and 40 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Touchette et al. Since the independent claims are now in condition for allowance as noted above, their depending claims are also in condition for allowance. The depending claims of the present application are not now made obvious by the Touchette reference or the Touchette reference in combination with the Chen reference and it is requested that the rejection be withdrawn.

Allowable Subject Matter

Claims 9, 20, 29, 35, 37-39, 48, 49, 51, 54-57 and 60 were objected to as being dependent upon a rejected base claim, but were indicated allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The applicant is grateful for the noted indication of allowability.